

CLAIMS

1. The method for deriving an electrical output from solar radiation, comprising the steps of:

(a) providing a multijunction photovoltaic cell having, a series connected array of junction unit cells with a stack orientation, a multijunction defined edge illumination receiving surface, an electrical output derivable at terminals and formed of impurity doped photovoltaic material exhibiting a given bandgap energy at a bandgap energy wavelength and a wavelength defined band of useful energy extending below said bandgap energy wavelength;

(b) concentrating said solar radiation within a concentration light path;

(c) removing components of solar energy at said concentration light path corresponding with at least a portion of those wavelengths substantially ineffective to evoke said cell electrical output to derive a corrected concentration light path;

(d) directing said corrected concentration light path in an impinging direction upon said cell edge illumination receiving surface effective to permit generation of said electrical output; and

(e) coupling said terminals with a load.

2. The method of claim 1 in which said multijunction photovoltaic cell as have a said stack orientation disposed at a stack angle less than 90° with respect to said receiving surface.

3. The method of claim 2 in which said step (a) provides said stack angle is generally equivalent to Brewster's angle.

4. The method of claim 1 in which said step (c) is carried out with a dichroic device removing solar energy corresponding with wavelengths greater than said bandgap energy wavelength.

5. The method of claim 1 in which said step (a) wavelength defined band of useful energy extends from said bandgap energy wavelength to about one-half said bandgap energy wavelength.

6. The method of claim 1 in which said step (c) is carried out with a dichroic device removing solar energy corresponding with wavelengths below said wavelength defined band of useful energy.

7. The method of claim 1 in which said step (d) directs said corrected concentration light path in a manner effective to impinge light upon said cell edge illumination receiving surface at a substantially uniform integrity.

8. The method of claim 7 in which said uniform energy level is derived with a prism.

9. The method of claim 7 in which:
said step (b) is carried out with a mirror implemented primary concentrator reflecting solar radiation to define said concentration light path; and
said step (d) directs said corrected concentration light path with a secondary concentrator having a centrally disposed axis, an entrance of given dimensional extent located to receive said corrected concentration light path, an exit adjacent said edge illumination receiving surface of dimensional extent less than said given dimensional extent, and having a sloping internally reflecting surface characteristic effective to progressively angularly reflect said corrected concentration light path to an extent at least effecting five or more internal reflections.

10. The method of claim 1 in which said step (a) wavelength defined band of useful energy extends from said bandgap energy wavelength to about one-half said bandgap energy wavelength.

11. The method of claim 1 in which:
said step (b) is carried out with a mirror implemented primary concentrator reflecting solar radiation;
said step (d) includes the step:

(d1) providing a secondary concentrator having a centrally disposed axis, an entrance of given dimensional extent located to receive said concentration light path, an exit adjacent said edge, illumination receiving surface of dimensional extent less than said given dimensional extent and having a sloping internally reflecting surface effective to progressively angularly reflect light impinging thereon to effect its homogenization; and

said step (c) is at least partially carried out by providing said internally reflecting surface as a dichroic device.

12. The method of claim 11 in which said step (d) secondary concentrator sloping internal reflecting surface characteristic is provided as an inwardly depending logarithmically defined surface.

13. The method of claim 11 in which said step (d) secondary concentrator sloping internal surface is provided as an inwardly sloping surface having a slope angle of about 7° to about 12° with respect to said centrally disposed axis.

14. The method of claim 9 in which said step (d) secondary concentrator sloping internal reflecting surface characteristic is provided as an inwardly depending logarithmically defined surface.

15. The method of claim 9 in which said step (d) secondary concentrator sloping internal surface is provided as an inwardly sloping surface having a slope angle of about 7° to about 12° with respect to said centrally disposed axis.

16. The method of claim 1 in which:
said step (b) is carried out with a spherical mirror implemented primary concentrator imaging solar radiation as a coma of light distribution, and a coma corrector lens imaging said coma of light distribution at an image focal point defining said concentration light path.

17. The method of claim 7 in which:

said step (b) is carried out with an etalon mirror implemented primary concentrator reflecting solar radiation to an image point defining said concentration light path; and

said step (d) directs said corrected concentration light path to impinge light upon said cell edge illumination receiving surface at a substantially uniform intensity by providing said etalon mirror with one or more substantially flat reflective surfaces.

18. The method of claim 1 in which:

said step (a) provides more than one said multijunction photovoltaic cell each said cell being formed of a unique photovoltaic material exhibiting a unique bandgap energy wavelength and a unique wavelength defined band of useful energy;

said step (c) removes components of solar energy corresponding with wavelengths greater than said unique bandgap energy wavelength with respect to each said cell to derive more than one unique corrected concentration light path; and

said step (d) directs each said unique corrected concentration light path to impinge upon the illumination receiving surface of a corresponding unique cell.

19. The method of claim 18 in which:

said step (a) provides one said multijunction photovoltaic cell as a stacked germanium junction cell exhibiting a germanium wavelength defined band of useful energy; and

provides another said multijunction photovoltaic cell as a stacked silicon junction cell exhibiting a silicon bandgap energy wavelength generally at a lower terminus of said germanium band of useful energy and having a wavelength defined silicon band of useful energy;

said step (c) is carried out with a first dichroic device removing solar energy corresponding with wavelengths greater than said germanium bandgap energy wavelength to derive a corrected germanium concentration light path; and

with a second dichroic device removing solar energy corresponding with wavelengths substantially extending from said silicon bandgap energy wavelength to said germanium bandgap energy wavelength to derive a corrected silicon concentration light path; and

said step (d) diverts said corrected germanium concentration light path to the edge illumination receiving surface of said germanium junction cell; and

directs said corrected silicon concentration light path to the edge illumination receiving surface of said silicon junction cell.

20. The method of claim 18 in which:

said step (a) provides one said multijunction photovoltaic cell as a stacked silicon junction cell exhibiting a silicon bandgap energy wavelength and wavelength defined silicon band of useful energy, and

5 provides another said multijunction photovoltaic cell as a stacked gallium arsenide cell exhibiting a gallium arsenide bandgap energy wavelength generally at the terminus of said silicon band of useful energy and having a wavelength defined gallium arsenide band of useful energy;

10 said step (c) is carried out with a first dichroic device, removing solar energy corresponding with wavelengths greater than said silicon bandgap energy wavelength to derive a corrected silicon concentration light path, and

15 with a second dichroic device removing solar energy corresponding with wavelengths substantially extending from said gallium arsenide bandgap energy wavelength to said silicon bandgap energy wavelength to derive a corrected gallium arsenide concentration light path; and

said step (d) directs said corrected silicon concentration light path to the edge illumination receiving surface of said silicon junction cell, and

directs said corrected gallium arsenide concentration light path to the edge illumination receiving surface of said gallium arsenide junction cell.

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21. The method of claim 1 in which:

said steps (b) and (c) are carried out with a concentrator mirror assembly configured with diachronic components effective to remove said components substantially ineffective to evoke said cell electrical output.

22. The method for deriving an electrical output from solar radiation, comprising the steps of:

(a) providing a series-connected array of photovoltaic cells having an illumination receiving surface, a derivable electrical output, each cell of said array exhibiting a given bandgap energy at a bandgap energy wavelength and a wavelength defined band of useful energy extending below said bandgap energy wavelength;
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(b) concentrating said solar radiation within a concentration light path;

(c) removing components of solar energy from said concentration light path corresponding with at least a portion of those wavelengths substantially ineffective to evoke said cell electrical output to derive a corrected concentration light path; and

(d) directing said corrected concentration light path in an impinging direction toward said receiving surface effective to derive said electrical output.

23. The method of claim 22 in which said step (a) provides:
10 each said cell of said array of cells as a back surface point contact cell device.

24. The method of claim 22 in which said step (a) provides:
said array of cells as a series connected stacked array of junction
15 cells with a stack orientation and said receiving surface is a multijunction defined edge illumination receiving surface.

25. The method of claim 24 in which said step (a) provides:
said stacked array of junction cells stack orientation at a stack angle
20 less than 80° with respect to said edge illumination receiving surface.

26. The method of claim 25 in which said stack angle is generally equivalent to Brewsters angle.

27. The method of claim 22 in which said step (c) is carried out with a dichroic device removing solar energy corresponding with wavelengths greater than said bandgap energy wavelength.
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28. The method of claim 22 in which said step (a) wavelength defined band of useful energy extends from said bandgap energy wavelength to about one-half said bandgap energy wavelength.

5 29. The method of claim 22 in which said step (d) directs said corrected concentration light path toward said receiving surface in a manner effective to impinge light upon said receiving surface at a substantially uniform intensity.

30. The method of claim 22 in which said step (d) includes the step of:
10 (d1) homogenizing light within said corrected concentration light path prior to the impingement upon said receiving surface.

31. The method of claim 30 in which said step (d1) is carried out with a prism.
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32. The method of claim 30 in which:
said step (b) is carried out with a mirror implemented primary concentrator reflecting solar radiation to define said concentration light path; and
said step (d1) is carried out by directing said corrected concentration
20 light path with a non-imaging secondary concentrator having a centrally disposed axis, an entrance of given dimensional extent located to receive said corrected concentration light path, an exit adjacent said receiving surface of dimensional extent less than said given dimensional extent and having a sloping internally reflecting surface effective to progressively internally reflect said corrected concentration light
25 path to effect its homogenization.

33. The method of claim 32 in which said step (d1) sloping internal reflecting surface is provided as an inwardly depending logarithmically defined surface.
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34. The method of claim 32 in which said step (d1) secondary concentrator sloping internal surface is provided as an inwardly sloping surface having a slope angle of about 7° to about 12° with respect to said centrally disposed axis.

35. The method of claim 22 in which:
said step (b) is carried out with a mirror implemented primary concentrator reflecting solar radiation;
5 said step (d) includes the step:
(d2) providing a secondary concentrator having a centrally disposed axis, an entrance of given dimensional extent located to receive said concentration light path, an exit adjacent said receiving surface of dimensional extent less than said given dimensional extent and having a sloping internally reflecting
10 surface effective to progressively angularly reflect light impinging thereon to effect its homogenization; and
said step (c) is at least partially carried out by providing said internally reflecting surface on a dichroic device.
- 15 36. The method of claim 35 in which said step (d1) sloping internal reflecting surface is provided as an inwardly depending logarithmically defined surface.
- 20 37. The method of claim 35 in which said step (d1) secondary concentrator sloping internal surface is provided as an inwardly sloping surface having a slope angle of about 7° to about 12° with respect to said centrally disposed axis.
38. The method of claim 22 in which:
said step (b) is carried out with a spherical mirror implemented primary concentrator imaging solar radiation as a coma of light distribution, and a coma corrector lens imaging said coma of light distribution at an image focal point defining said concentration light path.
39. The method of claim 22 in which:
said step (b) is carried out with an etalon mirror implemented primary concentrator reflecting solar radiation to an image point defining said concentration light path; and

said step (d) directs said corrected concentration light path to impinge light upon said cell edge illumination receiving surface at a substantially uniform integrity by providing said etalon mirror with one or more substantially flat reflective surfaces.

40. The method of claim 22 in which:

said step (a) provides more than one said series-connected array of photovoltaic cells, each said array being formed of a unique photovoltaic material exhibiting a unique bandgap energy wavelength and a corresponding unique wavelength defined band of useful energy;

said step (c) removes components of solar energy effective to substantially match said unique bandgap energy wavelength and corresponding unique wavelength defined band of useful energy to derive corresponding unique corrected concentration light paths; and

said step (d) directs each said unique corrected concentration light path to the receiving surface of a corresponding unique array.

41. The method of claim 40 in which:

said steps (b) and (c) are carried out by providing more than one primary concentrator component, each comprising a transparent mirror component with a unique reflective dichroic component.

42. The method of claim 41 in which said step (b) is carried out with more than one transparent Fresnel lens component having parabolic concentrator attributes.

43. The method of claim 42 in which:

said step (b) is carried out with more than one forwardly disposed transparent Fresnel pattern having a given concentrator configuration each having a corresponding rearwardly disposed transparent and complementary pattern configuration effective to support said unique reflective dichroic component in mirror defining relationship with a corresponding said forwardly disposed transparent Fresnel pattern.

44. The method of claim 41 in which said step (b) is carried out with more than one transparent parabolic mirror.

45. The method of claim 41 in which said steps (b) and (c) provide said more than one primary concentrator components in mutually spaced relationship to effect a corresponding mutual separation of said unique corrected concentration light paths.

46. The method of claim 22 in which:
said step (c) carries out said components removal by effecting a frequency shift thereof.

47. The method of claim 46 in which said step (c) frequency shift is carried out with luminescence, phosphorescence, or fluorescence.

48. A system for deriving an electrical output from solar radiation, comprising:

a primary concentrator mirror reflectively responsive to said solar radiation and effecting the intensity concentration thereof:

a series-connected array of photovoltaic cells having an illumination receiving surface, each cell of said array exhibiting a given bandgap energy at a bandgap energy wavelength and a wavelength defined band of useful photon energy extending below said bandgap energy wavelength.

a corrector component responsive to treat and remove ineffective wavelength defined solar energy components from said intensity concentration of solar radiation to an extent effecting a substantial match of said concentrated solar radiation with said wavelength defined band of useful photon energy; and

a homogenizer component responsive to direct un-imaged corrector component treated radiation to impinge upon said illumination receiving surface with substantially uniform intensity.

49. The system of claim 48 in which said array of photovoltaic cells comprises:

a series connected stacked array of junction cells with a stack orientation, said receiving surface being a multijunction defined edge illumination receiving surface, and said stack orientation being at a stack angle less than 90° with respect to said edge illumination receiving surface.

50. The method of claim 49 in which said stack angle is generally equivalent to Brewster's angle.

51. The method of claim 48 in which:
said homogenizer comprises a prism.

52. The method of claim 48 in which said homogenizer component comprises:

a secondary concentrator having a centrally disposed axis, an entrance of given dimensional extent located to receive solar radiation from said primary concentrator mirror, an exit adjacent said receiving surface of dimensional extent less than said given dimensional extent and having a sloping internally reflecting surface effective to progressively internally reflect impinging thereon.

53. The method of claim 52 in which said secondary concentrator is configured to effect five or more internal reflections.

54. The method of claim 52 in which said secondary concentrator internally reflecting surface is an inwardly depending logarithmically defined surface.

55. The method of claim 52 in which said secondary concentrator sloping internally reflecting surface comprises an inwardly sloping surface having a slope angle of about 7° to about 12° with respect to said centrally disposed axis.

56. The method of claim 52 in which at least a portion of said corrector component is incorporated with said secondary concentrator internally reflecting surface.

57. The method of claim 48 in which at least a portion of said corrector component is incorporated with said primary concentrator mirror.

58. The method of claim 48 further comprising:

one or more unique additional series connected arrays of photovoltaic cells, each said array being formed of a unique photovoltaic material exhibiting a unique bandgap energy wavelength and a corresponding unique wavelength defined band of useful energy;

said corrector component is further responsive to remove ineffective wavelength defined solar energy components from said intensity concentration of solar radiation to an extent effecting a substantiated match of said concentrated solar radiation with each said unique wavelength defined band of useful energy; and

said homogenized component is responsive to direct said matched concentrated solar radiation to the receiving surface of a corresponding unique additional series connected array of photovoltaic cells.

59. The method of claim 48 in which:

said primary concentrator is configured as a Fresnel mirror having a lower edge and a rearward surface; and

further comprising:

a solar tracking primary concentrator mount including a circular, horizontally disposed support rail assembly, a carriage assembly mounted for rotational movement upon said support rail assembly; and

said Fresnel mirror lower edge being mounted for pivotal movement upon said carriage assembly between a substantially upright orientation and a substantially horizontal orientation.